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## THE OCCUPATION HAZARD OF LOCOMOTIVE FIREMEN.

By HENRY J. HARRIS.

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The occupation hazard of any employment is now a matter in which the general public is taking an ever-increasing interest. The recent wave of accident insurance legislation in the United States has called attention to the high accident rate in many of our industries and occupations; in the recent arbitration of a wage controversy between locomotive engineers and their employers, emphasis was placed on the fact that the trade life of the locomotive engineer was but from ten to twelve years; the presidents of two prominent trade unions not long ago urged that the protection of such organizations was necessary to prevent men from being thrown on the scrap heap at an early age under present-day conditions. We know so little, however, about the hazard of occupations and the length of working life at the present time that any attempt to measure the loss of a group of employees caused by accident, sickness, and general loss of working power from conditions peculiar to an occupation is usually blocked by the absence of any accurate information on these subjects.

For a few occupations there does exist a certain amount of scattered information which, when brought together, throws considerable light on this question. Among such, the occupations of locomotive firemen and locomotive engineers have frequently been studied from various points of view. By comparing the material collected from time to time by different agencies, one can obtain an estimate of the special risks and general hazard of these occupations which is sufficiently accurate to form the basis for some general conclusions in regard to the occupational hazard of the employment. The

study of the occupation of locomotive firemen is rendered difficult by the fact that it is as a rule a preliminary occupation, because most firemen are in the course of time promoted to the position of engineer. Partly on this account, the statistics of the Interstate Commerce Commission usually combine all men employed on trains in the reports of accidents, while in the federal mortality returns, all steam railroad employees are reported in one total. For this reason, it has been necessary to use the statistical data furnished by special studies and by sources less comprehensive than the federal statistics, or the returns of the Registrar-General of Great Britain.

#### EXTENT OF THE OCCUPATION.

The occupation returns of the census of 1910 present the class of locomotive firemen separately for the first time in the history of the census. The following table shows the figures for this occupation together with those for the locomotive engineers:

TABLE I.

#### NUMBER OF LOCOMOTIVE FIREMEN AND ENGINEERS IN THE CENSUS OF 1910, BY AGE GROUPS AND PARENTAGE.

(Source: Thirteenth Census of the United States, 1910, Vol. IV., Population-Occupation Statistics, pp. 416, 417.)

Age Groups and Parentage.	Locomotive Firemen.	Locomotive Engineers.
Total.....	76,381	96,229
Age groups:		
14 to 15 years.....	19	
16 to 20 years.....	6,627	891
21 to 44 years (including age unknown).....	66,257	66,605
45 years and over.....	3,478	28,733
Native white:		
Native parentage.....	49,674	62,672
Foreign or mixed parentage.....	15,108	23,062
Foreign-born white.....	6,395	10,133
Negro.....	5,188	355
Indian, Chinese, Japanese, and all others.....	16	7

The number of locomotive firemen in the United States as given above is 76,381. The report contains the warning that the enumerators did not always separate the stationary firemen and stationary engineers from those employed on locomotives so that the above total may be slightly in excess of the actual number, which may be assumed to be about 75,000 men. The number of members of the Brotherhood of Locomotive

Firemen and Enginemen on December 31, 1910, was 73,469; in 1911 it was 79,942 and in 1912 it was 85,292.\* As the organization includes a number of locomotive engineers, the figures are in substantial agreement with the census returns.

The general characteristics of the firemen's group are that it consists entirely of males, that it is a young men's occupation (the number over 44 years of age is only about 3,500 out of the total of 75,000), that the great majority (two thirds) are descended from American-born parents and that only about 6,000 of the 75,000 were foreign born.

The general characteristics of the firemen group, therefore, are such as would produce a favorable death-rate. This tendency is enhanced by the fact that applicants for employment as firemen are usually subjected to a careful medical examination by the surgeons of the railroad companies† and all applicants with physical defects or below a high standard of physique are rejected.

#### THE MORTALITY OF LOCOMOTIVE FIREMEN.

One of the most definite indications of the general hazard of an occupation consists of the death-rate of those engaged in that occupation. For locomotive firemen we have several computations of the death-rate. These computations were made by life insurance companies or by life insurance actuaries, and the rates compiled are based on their experience in insuring the lives of men engaged in this occupation. It is well to call attention to the fact that the persons insured are carefully selected by the insurance companies so that the group whose lives furnished the basis for these rates is composed of men of more than average prudence, selected by prudent insurance companies and engaged in an occupation in which only persons of excellent physique are employed. The death-rate for the occupation of locomotive firemen ought therefore to be a favorable one.

*The Medico-Actuarial Investigation.* The most recent study of the mortality of hazardous occupations in America is that entitled "Medico-Actuarial Mortality Investigation." It

\* Eastern Concerted Wage Movement, p. 276.

† For a typical form used in such examinations, see the New York Central Railroad blank reprinted in Eastern Concerted Wage Movement, p. 391.

was made by the Association of Life Insurance Medical Directors and the Actuarial Society of America and included the experience of the leading American life insurance companies. Only those occupations were included for which the number of deaths was large enough to form the basis of a rate. The following table gives a summary of the data for all the railroad occupations included in this investigation:

TABLE II.

ACTUAL AND EXPECTED NUMBER OF DEATHS OF LOCOMOTIVE FIREMEN AND OTHER RAILWAY EMPLOYEES ACCORDING TO THE MEDICO-ACTUARIAL INVESTIGATION.

(Source: Medico-Actuarial Mortality Investigation, 1913. Vol. III, pp. 132-141.)

Ages at Entry.	Railway Locomotive Firemen.		Railway Locomotive Engineers.		Railway Check Clerks, Freight Inspectors, Car Inspectors, Car Sealers, Yard Clerks and Yard Masters.		Railway Passenger Trainmen (not Conductors).		Railway Track Supervisors and Foremen. Section Foremen.	
	Actual Deaths.	Expected Deaths.	Actual Deaths.	Expected Deaths.	Actual Deaths.	Expected Deaths.	Actual Deaths.	Expected Deaths.	Actual Deaths.	Expected Deaths.
15-29	141	70.28	86	45.00	58	43.87	40	24.56	74	64.85
30-39	42	24.96	243	150.74	71	52.46	24	18.04	170	129.15
40-49	7	5.67	147	94.08	62	34.03	7	8.03	111	86.38
50-59	3	.93	62	42.64	29	23.08	4	4.09	56	40.99
60 and over	.....	.....	3	4.92	1	3.48	1	.80	10	11.70
Total	193	101.84	541	337.38	221	156.92	76	55.52	421	333.07

RATIO OF ACTUAL TO EXPECTED DEATHS.

15-29	201	100.0	191	100.0	132	100.0	163	100.0	114	100.0
30-39	168	100.0	161	100.0	135	100.0	133	100.0	132	100.0
40-49	123	100.0	156	100.0	182	100.0	87	100.0	129	100.0
50-59	323	100.0	145	100.0	126	100.0	98	100.0	137	100.0
60 and over	.....	100.0	61	100.0	29	100.0	125	100.0	85	100.0
Total	190	100.0	160	100.0	141	100.0	137	100.0	126	100.0

It should be stated that the "expected deaths" in the preceding table are those calculated by the M. A. Table, which will be found in the reports in Vol. I, page 89 and Vol. III, page 27.

The committee in charge of the investigation state that "generally the excess of the mortality ratio over 100 per cent. indicates the extent of the extra mortality due to the particular occupation in question" (Vol. III, page 6). The hazard of the firemen's occupation is, by the preceding table, shown to be

about 90 per cent. above the average of the persons accepted by the larger American life insurance companies. Of all the railway occupations included in the investigation, the firemen show the highest risk, though it must be remembered that certain occupations, *e. g.*, brakemen, undoubtedly have a higher risk and are accepted in such small numbers that the computation of a rate was not feasible. The group of locomotive engineers shows a distinctly lower hazard than the firemen; the difference, it will be noted, occurs in the younger age groups of the firemen. At the ages of entry, 15 to 29, the ratio for the engineers is 191 per cent. and for the firemen 201 per cent., and at ages 30 to 39 it is 161 per cent. and 168 per cent. respectively. Of the total policies 79 per cent. were issued to the firemen at ages 15 to 29, and 19 per cent. at ages 30 to 39, against 24 per cent. and 52 per cent., respectively, to the engineers.

*The Specialized Mortality Investigation.* An earlier investigation of the mortality of hazardous occupations, generally referred to as the "Specialized Mortality Investigation" which was conducted by the Actuarial Society of America, shows the same general tendencies among the railway employees.\* Because of the omission of certain types of risks, this study does not give as accurate results as the Medico-Actuarial Investigation, but the data are of value as showing the relative hazard of the occupations included, which comprise some not given in the later investigation. The following table summarizes the returns for all the occupations in this study connected with railroading:

\* Experience of thirty-four life companies upon ninety-eight special classes of risk, Compiled and published by the Actuarial Society of America, New York, 1903.

TABLE III.

ACTUAL AND EXPECTED NUMBER OF DEATHS OF LOCOMOTIVE FIREMEN AND OTHER RAILWAY EMPLOYEES AS COMPUTED BY THE ACTUARIAL SOCIETY OF AMERICA.

(Source: Experience of thirty-four life companies upon ninety-eight special classes of risk, p. 473.)

Ages at Entry.	Railway Locomotive Firemen.		Railway Locomotive Engineers.		Railway Express Messengers.		Railway Mail Clerks.		Railway Passenger Trainmen.		Railway Passenger Conductors.	
	Actual Deaths.	Expected Deaths.	Actual Deaths.	Expected Deaths.	Actual Deaths.	Expected Deaths.	Actual Deaths.	Expected Deaths.	Actual Deaths.	Expected Deaths.	Actual Deaths.	Expected Deaths.
15-28	37	21.2	29	22.9	13	16.5	24	28.9	9	5.5	33	30.2
29-42	20	14.0	135	108.7	13	17.8	31	37.3	12	8.4	122	136.3
43-56	3	2.7	55	37.3	7	3.9	9	13.0	3	2.2	49	35.7
57-70	1	.2	1	4.3	1	.1	1	1.5	.....	.3	3	4.6
15-70	61	38.1	220	173.2	34	38.3	65	80.7	24	16.4	207	206.8

RATIO OF ACTUAL TO EXPECTED DEATHS.

15-28	175.9	100.0	126.6	100.0	78.8	100.0	83.0	100.0	163.6	100.0	109.3	100.0
29-42	142.8	100.0	142.2	100.0	73.0	100.0	83.1	100.0	142.9	100.0	89.5	100.0
43-56	111.1	100.0	147.5	100.0	179.5	100.0	69.2	100.0	136.4	100.0	137.3	100.0
57-70	500.0	100.0	23.2	100.0	100.0	100.0	66.7	100.0	.....	100.0	65.2	100.0
15-70	160.1	100.0	127.0	100.0	88.0	100.0	80.5	100.0	146.3	100.0	100.1	100.0

The expected deaths in the above table are practically identical with Farr's Healthy English Male Table; the revised form of this table (as used in this study) will be found on page XIV of the report. The highest mortality is shown by the firemen with a ratio of actual to expected deaths of 160 per cent.; the passenger trainmen with 146 per cent. come next, while the locomotive engineers with a ratio of 127 per cent. rank third.

*Experience of the New York Life Insurance Company.* Similar results are shown by the study of Mr. Arthur Hunter, the actuary of the New York Life Insurance Company, based on the experience of that company.\* In that company the ratio of actual to expected deaths for locomotive firemen was 174 per cent., for locomotive engineers 145 per cent. Mr. Hunter remarks "the mortality among those insured as firemen appears to be much higher than among those insured as engineers, although it is hard to find an entirely satisfactory reason for such a considerable difference."

\* Transactions of the Actuarial Society of America, May, 1907, Vol. 10, No. 37.

*Change of Occupation.* In all of these actuarial studies, where the occupation is given as fireman, it means that such was the occupation when the policy was taken out, and this designation is retained in computing the death-rate even when the insured person was actually employed as an engineer at the time of his death. This fact, however, does not detract from the value of the tables as much as it might at first appear, because of the very high death-rates in the first few years after the insurance is taken out. The following table emphasizes this point:

TABLE IV.

ACTUAL AND EXPECTED DEATHS OF LOCOMOTIVE FIREMEN ACCORDING TO THE MEDICO-ACTUARIAL INVESTIGATION.

(Source: Medico-Actuarial Mortality Investigation, Vol. III, p. 137.)

Insurance Years.	Age at Entry 15-29.				Age at Entry 30-39.			
	Exposed to Risk.	Actual Deaths.	Expected Deaths.	Ratio per cent.	Exposed to Risk.	Actual Deaths.	Expected Deaths.	Ratio per cent.
1-5. . .	11,759	104	48.82	213	3,158	24	14.67	164
6-7. . .	2,028	14	9.92	141	661	6	3.71	162
8-10. .	1,546	14	7.72	181	653	6	3.99	150
11-15. .	643	9	3.42	263	334	6	2.44	246
16-24. .	67	.....	.40	.....	16	.....	.15	.....
1-24. .	16,043	141	70.28	201	4,822	42	24.96	168
40-49.					50-59.			
1-5. . .	376	2	2.68	75	40	1	61	164
6-7. . .	86	3	.86	349	7	1	16	625
8-10. .	77	2	.94	213	5	1	.16	625
11-15. .	48	.....	.82	.....	.....	.....	.....	.....
16-24. .	13	.....	.37	.....	.....	.....	.....	.....
1-24. .	600	7	5.67	123	52	3	.93	323
60 and Over.					All Ages at Entry.			
1-5. . .	.....	.....	.....	.....	15,333	131	66.78	196
6-7. . .	.....	.....	.....	.....	2,782	24	14.65	164
8-10. .	.....	.....	.....	.....	2,281	23	12.81	180
11-15. .	.....	.....	.....	.....	1,025	15	6.68	225
16-24. .	.....	.....	.....	.....	96	.....	.92	.....
1-24. .	.....	.....	.....	.....	21,517	193	101.84	190

The preceding table shows that the firemen's mortality rate is based on 193 deaths and that of these deaths, 131 occurred within five years after the policy was issued; the detailed tables of the investigation also show that 107 of the 193 deaths occurred in the first three years after the issue of the policy. It is safe to claim, therefore, that the rates of the various



actuarial studies are sufficiently accurate for present purposes as showing the high mortality of the occupation.

*Mortality of Brotherhood of Locomotive Firemen.* The death-rate of the membership of the Brotherhood of Locomotive Firemen and Enginemen also illustrates the hazard of the occupation, though as the figures include both firemen and engineers, they do not show a definite rate for firemen. The following table was prepared by the officers of the insurance organization of the Brotherhood:

TABLE V.

DEATHS AMONG THE MEMBERS OF THE BROTHERHOOD OF LOCOMOTIVE FIREMEN AND ENGINEMEN, 1882-1912.

(Source: Eastern Concerted Wage Movement, page 333.)

Years.	Number of Members.	Number of Deaths.	Deaths per 1000 Members.
1882.....	5,125	12	2.341
1883.....	7,888	44	5.578
1884.....	12,246	54	4.409
1885.....	14,849	74	4.973
1886.....	16,196	98	6.051
1887.....	17,047	81	4.751
1888.....	18,278	110	6.018
1889.....	17,087	127	7.432
1890.....	18,657	159	8.468
1891.....	22,460	190	8.459
1892.....	25,967	190	7.317
1893.....	28,681	226	7.878
1894.....	26,508	200	7.545
1895.....	21,408	129	6.026
1896.....	22,461	160	7.123
1897.....	24,251	145	5.919
1898.....	27,039	201	7.433
1899.....	30,748	220	7.155
1900.....	36,084	265	7.344
1901.....	39,072	300	7.678
1902.....	43,376	354	8.161
1903.....	48,568	647	13.321
1904.....	54,434	453	8.322
1905.....	55,287	496	8.971
1906.....	58,849	461	7.833
1907.....	62,916	581	9.234
1908.....	66,408	437	6.579
1909.....	65,315	412	6.308
1910.....	73,469	520	7.077
1911.....	79,942	523	6.542
1912.....	85,292	561	6.577

*Estimate of the Occupation Hazard by Life Insurance Practice.* The attitude of the larger life insurance companies towards the occupation of locomotive firemen has been determined by the facts just presented. Some of the companies refuse entirely to accept firemen while others accept them under certain restrictions. The New York Life Insurance Company, for

instance, in its circular of instructions to agents (Form 1519, issued May, 1912), explains that insurance will be accepted for certain hazardous occupations, but subject to the restriction that the applicant for insurance must pay the premiums for a higher age, and if the occupation is unusually hazardous, may be given only the endowment form of insurance. The circular (page 11) specifies that passenger conductors, express messengers, telegraphers, and train despatchers may be accepted at their actual age and may be given the regular life policies. Locomotive engineers must have 8 years added to their actual age and may receive no cheaper policy than a 20-year endowment. Locomotive firemen, however, must have 12 years added to their actual age and may receive no cheaper policy than a 20-year endowment.

*Comparison with other Occupations.* Of the occupations included in the medico-actuarial investigation, the mortality rate of firemen is exceeded only by certain occupations connected with mining and stonecutting; in addition, it is the highest of any of the railway occupations given in the report. To show the relation of the firemen's death-rate to those of other occupations, the following table presents, with two exceptions, all of the occupations included in the medico-actuarial investigation; the exceptions are, first, the numerous occupations connected with the liquor traffic, omitted as not being of interest in the present connection, and second, those occupations whose excess over the normal death-rate was less than 25 per cent.

\*The rules of a large number of American life companies on this point are cited in *Eastern Concerted Wage Movement*, pp. 338-

TABLE VI.  
MORTALITY RATES OF HAZARDOUS OCCUPATIONS.

(Source: Medico-actuarial Mortality Investigation, Vol. 3, pp. 28-31.)

Group Number.	Occupation.	Actual Deaths.	Expected Deaths.	Ratio of Actual to Expected Deaths.
44	Underground mines other than coal mines working miners. . . . .	642	283.66	226
188	Stone-cutters, journeymen. . . . .	76	35.45	214
42	Surface mines—placer, drift, hydraulic, etc. working miners. . . . .	70	33.72	208
45	Coal mines: working coal miners (anthracite). . . . .	66	34.55	191
58	Railways: locomotive firemen, excluding issues prior to 1890. . . . .	193	101.84	190
53	Potteries: employees molding potter's clay (excluding foremen and superintendents). . . . .	28	16.45	170
43	Underground mines other than coal mines: foremen and bosses. . . . .	54	32.12	168
64	Structural iron works (including house-smiths and bridge-builders). . . . .	74	43.96	168
41	Surface mines—placer, drift, hydraulic, etc.: foremen and bosses. . . . .	23	14.38	160
57	Railways: locomotive engineers, excluding issues prior to 1890. . . . .	541	337.38	160
47	Navy—commissioned officers (excluding chaplains, physicians, surgeons and paymasters). . . . .	149	97.79	152
13	Fire departments, city: firemen, ladder-men, pipe-men and hose-men. . . . .	155	104.55	148
16	Glass industry: bevelers, grinders, engravers and cutters of glass, excluding foremen and superintendents. . . . .	77	52.60	146
66	Theaters: actors (including vaudeville performers, but excluding acrobats and circus performers). . . . .	87	60.15	145
11	Electric light, heat and power systems: linemen (pole climbers) and arc light trimmers. . . . .	71	50.05	142
59	Railways: check clerks, freight inspectors, car inspectors, car sealers, yard clerks and yard masters. . . . .	221	156.92	141
50	Police and prisons: city policemen. . . . .	526	377.67	139
190	Steam vessels: officers and engineers in coastwise trade, excluding those traveling to the tropics. . . . .	34	24.69	138
56	Railways: passenger trainmen (not conductors) excluding issues prior to 1890. . . . .	76	55.52	137
68	Theaters: proprietors, managers and treasurers of theaters, music halls and vaudeville houses. . . . .	153	112.66	136
39	Underground mines—supervision: engineers, superintendents and managers occasionally going underground. . . . .	268	197.99	135
17	Hatters, journeymen. . . . .	84	62.74	134
51	Police and prisons: marshals, sheriffs and constables (excluding chief sheriffs not exposed to hazard from occupation). . . . .	475	355.07	134
46	Coal mines: working coal miners (bituminous). . . . .	45	34.22	132
1	Army-commissioned officers, excluding chaplains, physicians, surgeons and paymasters. . . . .	324	247.32	131
161	Motormen on street electric lines. . . . .	28	21.41	131
133	Domestic servants (women). . . . .	188	148.18	127
60	Railways: track supervisors and foremen and section foremen. . . . .	421	333.07	126
154	Livery stables—proprietors. . . . .	274	216.84	126

The occupations which are conspicuous for their high death-rates are: first, the miners and workers in stone and clay; second, the locomotive firemen; third, the structural iron

workers; and fourth, the locomotive engineers. The occupations connected with the liquor business rank with these groups. The risks connected with mining operations are well known and are so serious as to have a special government bureau devoted to their amelioration. The locomotive firemen may be said to rank next to the mining occupations.

## ACCIDENTS TO LOCOMOTIVE FIREMEN.

### FATAL ACCIDENTS.

*Returns of the Interstate Commerce Commission.* The accident reports of the Interstate Commerce Commission contain the most accurate returns of accidents to railway employees. Since the revised form of table was adopted in 1910 the fatal accident rates to employees engaged in the movement of trains has been as follows:

TABLE VII.

#### FATAL ACCIDENTS TO RAILROAD TRAINMEN\* 1911-1913.

NUMBER OF TRAINMEN IN SERVICE ON JUNE 30, 1911, 1912, AND 1913 AND NUMBER EMPLOYED FOR ONE KILLED.

(Interstate Commerce Commission Accident Bulletins 40, 44, and 48.)

Year.	Number Employed.	Number Killed.	Number Employed for one Killed.	Deaths per 1,000 Employees.†
1910-1911.....	235,841	1,218	194	5.16
1911-1912.....	245,653	1,182	208	4.81
1912-1913.....	251,111	1,173	231	4.67

\* "Trainmen" include enginemen, firemen, motormen, conductors, brakemen, rear flagmen, train baggagemen and train porters on trains.

† Computed.

The returns of the Commission do not give the data for locomotive firemen separately. The preceding table is given to show the high death-rate from accidents of the general class to which the firemen belong.

*Accident Rates Compiled by the United States Employers' Liability Commission.* The report of the United States Commission on Employers' Liability and Workmen's Compensation contains a study of accidents to railway employees covering the three years, 1908 to 1910; the returns were secured by the voluntary coöperation of the railroads, but include only selected roads where it is probable that the accident rate was lower than the average for the whole country. The following

table shows the results of this study for the two occupations of locomotive firemen and engineers:

TABLE VIII.

FATAL ACCIDENTS TO LOCOMOTIVE FIREMEN AND ENGINEERS, 1908-1910, AS REPORTED BY THE UNITED STATES EMPLOYERS' LIABILITY AND WORKMEN'S COMPENSATION COMMISSION.

(Source: Report of the Employers' Liability and Workmen's Compensation Commission, Vol. 1, pp. 147-148.)

Occupation.	Number of Employees.	Number of Deaths.	Deaths per 1,000 Employees.
Locomotive Firemen.			
Passenger.....	23,652	97	4.10
Freight.....	61,601	291	4.72
Yard.....	27,837	53	1.90
Mixed.....	4,520	20	4.42
Total.....	117,610	461	3.92
Locomotive Engineers.			
Passenger.....	23,425	130	5.55
Freight.....	55,717	231	4.15
Yard.....	25,876	43	1.66
Mixed.....	4,341	18	4.15
Total.....	109,359	422	3.86

The greater risk to the firemen is connected with freight traffic while to the engineer the higher risk comes from passenger traffic.

*Fatal Accidents in the Brotherhood of Locomotive Firemen.* The membership statement of the Brotherhood of Locomotive Firemen and Enginemen does not report the number of firemen, enginemen, hostlers, etc., separately. For the total membership, the number of deaths caused by railroad accidents is as follows:

TABLE IX.

DEATHS OF MEMBERS OF THE BROTHERHOOD OF LOCOMOTIVE FIREMEN AND ENGINE-  
MEN, 1904-1912, BY ACCIDENT AND OTHER CAUSES.

(Source: Eastern Concerted Wage Movement, pp. 276, 279.)

Year.	Number of Mem- bers.	Number and Cause of Death.			
		Railroad Accidents.	Diseases.	All Other.	Total.
1904.....	54,434	236	182	35	453
1905.....	55,287	260	203	33	496
1906.....	58,849	234	196	31	461
1907.....	62,916	287	260	34	581
1908.....	66,408	195	199	42	436
1909.....	65,315	182	195	34	411
1910.....	73,469	263	227	29	519
1911.....	79,942	214	250	58	522
1912.....	85,292	253	251	54	558

*The Medico-Actuarial Investigation.* In the medico-actuarial mortality investigation, the death-rate from accident is mentioned in the introductory text of Volume 3, but no tabulation is given. The text of the report shows that the mortality of locomotive firemen from accident is the highest of all the occupations included in the study, being "nine times the normal" (page 19). The next highest rate given is for locomotive engineers with "eight times the normal." In other occupations with high mortality rates, the accident mortality was distinctly lower than that for locomotive firemen; thus, for underground mining, other than coal mines, the fatal accident rate was "seven time the standard"; for anthracite coal miners six times, and for bituminous coal miners more than five times the standard; for structural iron workers, including house-smiths and bridge builders, the death-rate from accident was six times the normal.

*Ratings of the International Association of Accident Underwriters.* The attitude of the accident insurance companies towards the occupation of locomotive firemen is significant as showing the estimate of students of occupation risks from a commercial standpoint. Instead of using the estimates of individual companies, a general estimate made by the officials of the leading companies through their organization will be sufficient for present purposes. The International Association of Accident Underwriters has issued a "Classification of Occupations for Accident and Health Insur-

ance" (New York, 1912, The Spectator Company), in which the occupations which are accepted for accident insurance are rated in nine classes, the first class being the least dangerous and the ninth class the most dangerous. It should be stated, however, that class 9 includes only non-insurable risks and that class 8, the "Perilous" class, has practically no risks quoted in it except certain rolling mill employees; in fact, the edition of February 1, 1912, has only one reference to class 8. As a matter of fact, therefore, the standard list contains only seven classes of risks. It is significant that this seventh class, officially designated as "Extra Hazardous," is the one in which locomotive firemen are rated. The standard classifications shows, therefore, that the occupation of locomotive firemen is the most hazardous that the companies will accept for accident insurance; anything more dangerous will not be considered. This estimate of the fireman's risk is expressed concretely by the restriction on the amount of insurance allowed and by the premium rate charged. For safe risks, such as that of a general officer of a railroad, \$10,000 is the limit of an accident policy; for a locomotive engineer on a northern road, \$2,000 is the limit of policy, while for a fireman on a northern road \$1,000 is the highest policy permissible. The standard premium rates for a policy providing \$1,000 on death or \$5 per week during disability also emphasize the greater hazard of the fireman as contrasted with the engineer, as well as with other occupations. The following is the standard accident policy rate for locomotive firemen and engineers on northern roads:

COST OF AN ACCIDENT INSURANCE POLICY FOR LOCOMOTIVE FIREMEN AND ENGINEERS, AS COMPUTED BY THE INTERNATIONAL ASSOCIATION OF ACCIDENT UNDERWRITERS ON FEBRUARY 1, 1912.

Amount Payable for		Annual Premium for	
Death.	Weekly Indemnity.	Firemen.	Engineers.
\$1,000 and . . . . .	\$5	\$20	\$18.00
1,000 and . . . . .	10	35	31.50

Briefly stated, the fireman must pay \$20 for exactly the same policy which the engineer is given for \$18. The important fact, however, is that the fireman's occupation is on the margin of insurability; were the risk much greater, the occupation would probably be classed as non-insurable.

#### RISK OF BODILY INJURY.

*Rate of Injury.* It is the experience of the German workman's insurance system that the great number of physical injuries which disable men temporarily cause more economic loss to the group of employees than the deaths. In the case of locomotive firemen, the muscular strain of his occupation, combined with the conditions under which he performs his work, makes this occupation unusually prolific of injuries to various parts of the body. The general group of train employees has the following rate for physical injuries:

TABLE X.

INJURIES TO RAILROAD TRAINMEN,\* NUMBER OF TRAINMEN IN SERVICE ON JUNE 30, 1911-1913, AND THE NUMBER EMPLOYED FOR ONE INJURED.

(I. C. C. Accident Bulletins 40, 44, and 48.)

Year.	Number Employed.	Number Injured.	Number Employed for One Injured.	Injuries per 1,000 Employees.†
1910-11.....	235,841	29,306	8.0	124.3
1911-12.....	245,653	30,592	8.0	124.5
1912-13.....	251,111	34,183	7.3	136.1

\* "Trainmen" include enginemen, firemen, motormen, conductors, brakemen, rear flagmen, train baggagemen and train porters on trains.

† Computed.

That the risk of injury to which train employees are subjected is extremely high is obvious from the above rate. No separate figures for firemen are given.

The most recent study of bodily injury of railway employees is that of the United States Workmen's Compensation Commission which covered the three years 1908, 1909, and 1910. The information represents the experience of companies operating approximately one half of the total railway mileage of the United States and employing nearly 57 per cent. of all railway employees, excluding officers. The following table shows the data for locomotive firemen and engineers:



TABLE XI.

NUMBER OF INJURIES TO LOCOMOTIVE FIREMEN AND ENGINEERS, 1908-1910.  
(Source: Report of United States Employers' Liability and Workmen's Compensation Commission, Vol. 1, p. 148.)

Occupation.	Number of Employees.	Permanent Total Disability.	Permanent Partial Disability.	Temporary Disability (Over 2 Weeks).
Locomotive Firemen.				
Passenger.....	23,652	2	30	1,183
Freight.....	61,601	12	126	4,582
Yard.....	27,837	4	30	926
Mixed.....	4,520	1	7	152
Total.....	117,610	19	193	6,843
Locomotive Engineers.				
Passenger.....	23,425	6	24	807
Freight.....	55,717	10	62	2,664
Yard.....	25,876	5	32	717
Mixed.....	4,341	—	3	95
Total.....	109,359	21	121	4,283

TABLE XII.

RATE OF INJURY TO LOCOMOTIVE FIREMEN AND ENGINEERS, 1908-1910.

Occupation.	Number of Employees.	Rate per 1,000 Employees.		
		Permanent Total Disability.	Permanent Partial Disability.	Temporary Disability (Over 2 Weeks).
Locomotive Firemen.				
Passenger.....	23,652	.08	1.27	50.02
Freight.....	61,601	.19	2.05	74.35
Yard.....	27,837	.14	1.08	33.27
Mixed.....	4,520	.22	1.55	33.63
Total.....	117,610	.16	1.64	58.18
Locomotive Engineers.				
Passenger.....	23,425	.26	1.02	34.45
Freight.....	55,717	.18	1.11	47.81
Yard.....	25,876	.19	1.24	27.71
Mixed.....	4,341	—	.69	21.88
Total.....	109,359	.19	1.11	39.16

The preceding tables show that there is little difference between the firemen and engineers as regards total permanent disablements, but that these cases are relatively few in number. The cases of permanent partial disablement show that the fireman is injured about 50 per cent. more often than the engineer. The cases of temporary disablement also show that the fireman's risk is about 50 per cent. greater than that of the engineer.

*Nature of Injuries Sustained.* Among railway employees one of the most frequent and serious causes of injury and loss of time is the spraining of joints and muscles. A special study on this subject by Doctor Sneve, Chief Surgeon of the Chicago Great Western Railway, explains that of the accidents reported on this road, sprains and strains of joints and muscles made up 14.45 per cent. of the total. Doctor Sneve says (p. 47) "six years of experience in railroad work leads me to believe that these are precisely the injuries which lay up the employees the greatest length of time."

Doctor Sneve then gives statistics of these injuries reported on his road in the year 1899:\*

\* American Academy of Railway Surgeons, 1900, pp. 45-46.

TABLE XIII.

## SPRAINS AND STRAINS TO MUSCLES AND JOINTS OF EMPLOYEES OF CHICAGO, GREAT WESTERN RAILROAD, 1899.

Character of Injury.	Number.	Cause of Injury.	Number.
Firemen.			
Thumb.....	2	Falling down.....	17
Wrist.....	4	Shaking grates.....	3
Lumbar.....	5	Collision.....	1
Shoulder.....	4	Muscular exertion.....	3
Foot and ankle.....	2		
Knee.....	2		
Hip and thigh.....	3		
Forearm.....	1		
Side.....	1		
Total.....	24		24
Brakemen.			
Shoulder.....	3	Arm twisted.....	1
Knee.....	2	Muscular exertion.....	1
Arm.....	1	Falling.....	7
Elbow.....	1	Turning foot.....	2
Foot and ankle.....	5	Lifting.....	2
Lumbar.....	2	Collision.....	1
Total.....	14		14
Engineers.			
Lumbar.....	5	Switching.....	1
Wrists.....	2	Wreck.....	1
Leg.....	1	Falls.....	5
Elbow.....	1	Arm caught.....	1
Thumb.....	1	Collision.....	1
		Tank tipped.....	1
Total.....	10		10
Section Hands.			
Inguinal region.....	1	Struck stove.....	1
Foot and ankle.....	2	Falls.....	4
Abdominal muscles.....	1	Collision.....	2
Wrists.....	3	Turned foot.....	1
Knee.....	1	Lifting.....	2
Neck.....	2		
Total.....	10		10
Miscellaneous.			
Knee.....	2	Falls.....	18
Wrist.....	6	Muscular exertion.....	2
Side.....	2	Scuffling.....	1
Ankle and foot.....	13	Caught foot.....	4
Lumbar.....	6	Lifting.....	2
Leg.....	2	Turning foot.....	5
Finger.....	1		
Total.....	32		32

Doctor Sneve's comment on this table is as follows:

"It will be seen from the table that, as far as occupation is concerned, the greatest number injured, strangely enough, were fireman . . . ."

"We would have expected *a priori* that the number of sprains would have been greatest in the brakemen, who are continually climbing over cars and running backward and forward along the train, but the number of those so injured was only 14. Next were engineers and section hands, . . . and finally all other occupations."

"It appears that engineers hurt their backs, brakemen their ankles, while the firemen sprain backs, wrists, and shoulders indifferently."

To sum up this statement, the testimony of an experienced chief railway surgeon is to the effect that, of the injuries which he believes disable railroad men the greatest length of time, locomotive firemen are injured more than the other railroad employees, and that the nature of their occupation exposes practically all parts of the body to such injury.

*Firemen's Injuries Reported in Illinois.* The 1910 law of the State of Illinois requires the employer to report to the State bureau of labor all cases of accidents causing disability for more than 30 days. The following table is a list of such injuries which were reported for locomotive firemen to the State bureau during the year 1911:

TABLE XIV.

## NON-FATAL ACCIDENTS TO LOCOMOTIVE FIREMEN ON STEAM RAILROADS IN ILLINOIS, 1911.

Name of Railroad.	Date of injury.	Character and Cause of Injury.	Duration of Disability (Days).
C. and A.	Mar. 28	Foot amputated—run over by car. . . . .	*
C. B. & Q.	Feb. 24	Wrist broken—fell into pit. . . . .	42
C. B. & Q.	Feb. 26	Arm broken—fell over hydrant. . . . .	120
C. B. & Q.	May 6	Arm broken—fell from engine. . . . .	90
C. B. & Q.	May 15	Head injured—engine derailed. . . . .	61
C. B. & Q.	June 9	Ankle injured—falling iron. . . . .	42
C. B. & Q.	June 21	Back injured—collision. . . . .	40
C. B. & Q.	Sept. 19	Arm broken—fell off engine. . . . .	33
C. B. & Q.	Oct. 17	Arm broken—engine and car. . . . .	51
C. B. & Q.	Nov. 13	Arm broken—caught in engine wheel. . . . .	74
C. & E. Ill.	Feb. 9	Finger injured—shaker bar and can rack. . . . .	37
C. & E. Ill.	May 12	Body burned—gas explosion. . . . .	46
C. & E. Ill.	May 27	Leg injured—fell from stool. . . . .	31
C. & E. Ill.	July 21	Body injured—getting off engine. . . . .	35
C. & E. Ill.	Oct. 11	Head injured—struck by car. . . . .	30
C. & E. Ill.	Nov. 15	Leg injured—fell into pit. . . . .	33
C. & E. Ill.	Nov. 17	Leg burned—hot water. . . . .	64
C. G. W.	Feb. 2	Head injured—fell off engine. . . . .	30
C. G. W.	May 22	Wrist broken—fell off engine. . . . .	90
Ch. Jct.	Aug. 4	Eye destroyed—struck by crane lever. . . . .	38
Ch. Jct.	Aug. 22	Collar bone broken—fell from engine. . . . .	50
C. & N. W.	Jan. 19	Arm broken—flying iron. . . . .	90
C. & N. W.	May 3	Leg injured—struck tank. . . . .	70
C. R. I. & P.	Apr. 8	Ankle sprained—getting off engine. . . . .	47
C. R. I. & P.	June 6	Leg amputated—run over by train. . . . .	150
C. R. I. & P.	Oct. 1	Ankles sprained—fell on coal. . . . .	120
C. R. I. & P.	Dec. 15	Ribs broken—fell into pit. . . . .	31
E. J. & E.	June 9	Knee injured—jumped from engine. . . . .	75
Ill. Cent.	Feb. 10	Foot broken—jumped from engine. . . . .	120
Ill. Cent.	Feb. 10	Head injured—engine and car. . . . .	90
Ill. Cent.	Mar. 16	Hand injured—lever and box. . . . .	32
Ill. Cent.	May 5	Nose broken—jumped from engine. . . . .	60
Ill. Cent.	May 8	Ribs broken—fell against door opener. . . . .	36
Ill. Cent.	May 10	Leg broken—fell from engine. . . . .	90
Ill. Cent.	May 21	Rib broken—falling bar. . . . .	45
Ill. Cent.	June 1	Ankle sprained—jumped from engine. . . . .	49
Ill. Cent.	June 15	Back injured—fell from engine. . . . .	30
Ill. Cent.	July 22	Finger mashed—car and barrel. . . . .	42
Ill. Cent.	Oct. 13	Back injured—fell on engine deck. . . . .	31
Ill. Cent.	Oct. 18	Head injured—engine and car. . . . .	30
Ill. Cent.	Nov. 4	Head cut—engine and car. . . . .	31
Ill. Cent.	Nov. 16	Head injured—engine and signal staff. . . . .	44
Ill. Cent.	Nov. 29	Leg broken—fell from engine. . . . .	†
Ill. Cent.	Dec. 28	Collar bone broken—car and engine. . . . .	102
L. S. & M. S.	Jan. 23	Body injured—fell from car. . . . .	36
M. and C.	Apr. 2	Foot injured—falling coal. . . . .	32
M. and C.	Aug. 10	Arm broken—fell from engine. . . . .	42
M. and C.	Dec. 13	Back injured—falling coal. . . . .	33
St. L. I. N. & S.	Feb. 20	Ankle broken—collision. . . . .	180
St. L. I. N. & S.	June 8	Leg burned—hot water. . . . .	55
St. L. I. N. & S.	Nov. 28	Shoulder injured—fell from tank. . . . .	36
St. L. Br. Term'l	Dec. 3	Collar bone broken—fell from engine. . . . .	60
St. L. Troy & E.	Sept. 25	Leg amputated—run over by car. . . . .	*
S. R. Co.	June 17	Body injured—engine derailed. . . . .	35
T. P. & W.	Apr. 8	Body injured—collision. . . . .	36
Vandalia	Apr. 9	Eye injured—flying coal. . . . .	34

\* Permanent.

† Over 30 days.

Because the above table includes only injuries causing disability for more than 30 days, the number included is relatively small. Of the 56 accidents here listed, the number of days

lost is given for 53 cases and amounted to 3,031 days, or an average of 57.4 days per injury. The table indicates the general hazard of the occupation by the uniform manner in which the injuries affected the different parts of the body; head injuries number 10, trunk injuries 16, arm injuries 12, and leg injuries 18. Bone fractures number 23, or 50 per cent. of the total. In most industries, the risk of injuries is usually limited to one part of the body and it is possible to provide safety appliances to prevent accidents. The firemen's occupation, however, exposes his whole body and there seems to be practically no means of protecting him against the inherent hazard of his employment.

#### OCCUPATIONAL DISEASES.

The diseases connected with the occupation of locomotive fireman are of the same kind as occur in other occupations, but affect firemen in a greater degree than other employees because of the conditions connected with the firemen's work. Special classes of diseases peculiar to certain occupations, such as miners' asthma, or metal poisoning (lead, arsenic, etc.), do not occur in the case of firemen.

The experience of the mutual insurance organization of the Brotherhood of Locomotive Firemen and Enginemen is practically the only source of information on this subject available at the present time. A table compiled by this organization gives a comparison of its experience with that of two large fraternal insurance societies; this table is as follows:

TABLE XV.

## MORTALITY EXPERIENCE OF BROTHERHOOD OF LOCOMOTIVE FIREMEN, MODERN WOODMEN OF AMERICA, AND WOODMEN OF THE WORLD, SELECTED BY CAUSES.

(Source: Eastern Concerted Wage Movement, p. 332.)

Cause of Death or Disability.	Modern Woodmen of America.			Brotherhood of Locomotive Firemen and Enginemen.			Woodmen of the World.		
	Number of Members Exposed to Risk in 27 Years was 10,238,726.			Number of Members Exposed to Risk in 31 Years was 1,125,608.			Number of Members Exposed to Risk in 20 Years was 3,803,740.		
	Number of Claims.	Rate per 1,000 Members Exposed.	Per Cent. of Loss.	Number of Claims.	Rate per 1,000 Members Exposed.	Per Cent. of Loss.	Number of Claims.	Rate per 1,000 Members Exposed.	Per Cent. of Loss.
Typhoid fever.....	4,108	.4012	7.64	735	.653	6.95	2,673	.7024	8.55
Tuberculosis.....	7,907	.77225	14.71	1,012	.899	9.58	4,277	1.1239	13.69
General disease, inc. cancer	4,680	.4570	8.70	194	.1723	1.83	2,334	.6134	7.79
Heart disease and other circulatory disease.....	7,162	.6995	13.32	461	.4095	4.36	2,426	.6375	7.76
Bright's disease and other genito-urinary disease...	3,405	.33255	6.33	339	.3010	3.20	2,307	.6062	7.38
Other zymotic disease.....	1,993	.19465	3.71	436	.3873	4.12	1,519	.3992	4.86
Pneumonia.....	4,912	.4797	9.14	394	.3499	3.73	3,582	.9413	11.43
Other respiratory disease...	918	.08965	1.71	53	.0470	.50	620	.1629	1.98
Digestive disease.....	4,989	.4872	9.28	416	.3694	3.93	2,923	.7681	9.35
Nervous disease.....	4,177	.40795	7.77	625	.5552	5.91	2,126	.5587	6.80
Violence, including suicide and amputations.....	8,665	.8463	16.12	5,587	4.9635	52.86	5,101	1.3415	16.32
Blindness.....	.....	.....	.....	163	.1448	1.54	.....	.....	.....
Unclassified.....	847	.0827	1.57	153	.1359	1.45	1,258	.3306	4.03
Total.....	53,763	5.25065	100.00	10,568	9.3878	99.96	31,146	8.1857	99.94

The rates given in the preceding table are suggestive in certain regards. Of the three societies, the Modern Woodmen have the most favorable general rate (5.25 per 1,000 members); the rate for the Woodmen of the World is 8.1857 and for the firemen 9.3878 per 1,000 members. The firemen's rate, however, includes the extremely high rate of 4.9635 for violence, etc. Next to this rate, that for blindness is conspicuous. This high rate is in part caused by exposure to the heat and strong light of the firebox on the locomotive.\* It is evident that loss or impairment of eyesight must be considered an occupational disease of firemen. The detailed tables prepared by the firemen's insurance organization show a surprising number of injuries to the eyes from bursting of water glasses or other gauges.

\* Eastern Concerted Wage Movement, pp. 289 to 304, 315-320. See also Proceedings before the Board of Arbitration, 1913, pp. 457-513.

The preceding table, unfortunately, provides no information as to the age grouping of the various societies. Undoubtedly the organization of the firemen, with its large proportion of young men, should have a low rate for heart disease and circulatory disease—perhaps even lower than that shown in the table. The rate for nervous diseases is high, though not higher than that of the Woodmen of the World; here again, the influence of the age grouping is probably the decisive factor.

#### GENERAL CONCLUSIONS.

There is general agreement that the occupation of locomotive fireman is “extra hazardous.”

There is general agreement that the mortality rate of locomotive firemen is higher than that for engineers.

Two special studies of mortality conducted by the Actuarial Society of America show that the occupation of locomotive firemen has a higher death rate than the rate for engineer, express messenger, mail clerk, passenger trainman, passenger conductor, and track supervisor.

As compared with other hazardous occupations, locomotive firemen have a mortality rate which is about the same as that for anthracite miners, but is higher than the rate for potters, for structural iron workers, for locomotive engineers, etc.

Fatal accidents cause about 50 per cent. of the deaths of the members of the firemen's insurance organization. Fatal accidents occur more frequently to firemen than to any other occupation included in the Medico-Actuarial Investigation; they were, for instance, distinctly more frequent than for miners of any kind, or for structural iron workers.

The standard rating of accident insurance companies groups locomotive firemen in the most dangerous class for which they accept insurance.

The risk of temporary disablement and of permanent partial disablement is 50 per cent. higher for firemen than it is for engineers.

The fireman seems to be more exposed to injuries like strains and sprains (which cause greater loss of time than other injuries) than any other group of railway employees.



The fireman's injuries affect all parts of his body and special protection against them seems impossible. Fractured bones are a conspicuous feature of his injuries.

Loss and impairment of eyesight and liability to nervous disease are special hazards of the fireman's occupation.

While part of the fireman's risk is due to the fact that the "new-comer" in any occupation has a high accident rate, the general hazard of the occupation is so great as to be principally responsible for the high rates for death and injury.

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